Poliomyelitis, OPV, and Misconceptions on Vaccinations

August, 2000

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This document was developed by U.S. Pharmacopeia (USP) to support the U.S. Agency for International Development (USAID) and its partners in the global campaign to eradicate poliomyelitis. It includes discussion of the disease and prevention with oral poliovirus vaccine (OPV), and addresses misinformation and superstitions that are known to exist in various parts of the world regarding vaccination.

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This document was reviewed by the USP Expert Advisory Panels on Infectious Disease Therapy, International Health, and Pediatrics; by polio experts/reviewers from around the world and from various agencies, including the World Health Organization (WHO), United Nations Children's Fund (UNICEF), and the U.S. Centers for Disease Control and Prevention (CDC); and by the general public. Their assistance is acknowledged.

This publication is made possible through the support provided by the Office of Health and Nutrition, U.S. Agency for International Development, through the Rational Pharmaceutical Management Project Cooperative Agreement No. HRN-A-00-92-00052. The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of the U.S. Agency for International Development.

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General Considerations

Poliomyelitis is an infectious disease caused by three types (serotypes 1, 2, and 3) of poliovirus, which is an enterovirus (a type of virus that inhabits the intestinal tract). The three serotypes are not cross-protective, which means that the individual must develop immunity to each type for complete protection against the disease. (1, 2) In countries where poliomyelitis is endemic, the disease often is caused by poliovirus serotype 1, less frequently by poliovirus serotype 3, and least frequently by poliovirus serotype 2. (1)

Poliomyelitis can be transmitted directly by fecal-oral contact or indirectly by contact with infectious saliva or feces (or by contaminated sewage or water). (79, 86) Polioviruses enter the mouth and replicate in the oropharynx and intestinal tract. (1, 2) From there, the viruses are carried by the blood stream into the central nervous system (CNS), resulting in cell destruction of the motor neurons of the anterior horn and the brain stem. (1, 2) (The exact mechanism by which the CNS becomes infected, however, remains uncertain and controversial. A study involving transgenic mice expressing the human poliovirus receptor suggested that poliovirus spreads from muscle to CNS by means of peripheral nerve muscle fibers, rather than directly from the blood stream.) (3) Motor function of the individual is therefore impaired while the sensory function remains unaltered. (1, 2)

Paralytic symptoms usually occur 7 to 21 days from the time of initial infection (range is from 4 to 30 days). The period of communicability starts after viral replication, continuing as the virus is excreted in oral secretions and feces. Communicability ends when replication and excretion of virus cease, which usually occurs 4 to 6 weeks after infection. More than 90% of susceptible contacts become infected after household exposure to the wild poliovirus. (1)

Clinical Findings

Diagnosis/Laboratory Findings

Poliomyelitis can be diagnosed by recovery of polioviruses from throat secretions in the early phase of illness (first week), from feces (often for several weeks), and rarely from the cerebrospinal fluid (CSF). Virus isolates are classified as either wild-type (naturally occurring strains) or vaccine-like. Diagnosis also can be established by serologic testing to demonstrate seroconversion (i.e., development of antibodies in response to the infection). (4) Serologic techniques, however, require paired sera, are difficult to interpret, and do not distinguish between wild and vaccine virus. (87, 88) Laboratory findings may include a normal or mildly elevated white blood cell count and CSF findings that are indistinguishable from other viral causes of aseptic meningitis. (4)

Symptoms and Signs

About 95% of poliomyelitis infections are asymptomatic; these inapparent cases still are considered infectious. (2) Abortive (minor illness) type of poliomyelitis occurs in about 4 to 8% of infections and its manifestations include fever, headache, sore throat, listlessness, anorexia, vomiting, and abdominal pain. Neurologic examination is normal. The illness lasts from a few hours to about 2 to 3 days and is clinically indistinguishable from other nonspecific viral infections; it can be suspected clinically during an epidemic. The major illness types include nonparalytic and paralytic poliomyelitis. Nonparalytic poliomyelitis has more severe systemic manifestations than the abortive type, and with positive signs of meningeal irritation that make it clinically indistinguishable from aseptic meningitis caused by other enteroviruses. (4)

Paralytic poliomyelitis can be classified as spinal, bulbar, or spino-bulbar disease. The development of paralysis is rapid (about 2 to 4 hours), is usually accompanied by fever and muscle pain, rarely progresses after the patient's temperature has returned to normal, and usually is completed by 3 days. (88) Spinal paralysis is usually asymmetric affecting one or more limbs. Deep tendon reflexes are absent or diminished. Bulbar paralysis is a serious form of poliomyelitis. It involves the medulla oblongata which

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contains important collection of nerve cells dealing with vital functions such as respiration and swallowing. (1)

Many patients recover some muscle function after the acute episode. Prognosis can be firmly assessed usually within 6 months after the onset of paralytic manifestations. (1)

Differential Diagnosis

Paralytic poliomyelitis may be confused with Guillain-Barré syndrome; in the latter, (a) the muscle weakness is more symmetric and ascending, with onset over a longer period of time (several days to 1 week) (4, 7, 88, 106), and with loss of sensation in about 80% of cases; (b) paresthesia (which is an abnormal touch sensation such as burning or prickling often occurring in the absence of external stimulus) is common; and (c) CSF findings consist of high protein content with normal or minimal pleocytosis (presence of a greater than normal number of cells in the CSF). (4) Other than Guillain-Barré syndrome, atypical/typical presentation of poliomyelitis may be mistaken for other clinical entities such as transverse myelitis (an inflammation of the spinal cord) (7), traumatic neuritis, infection caused by other enteroviruses (notably enterovirus 71 (87); coxsackieviruses A7 (115); A9, or A23 [echovirus 9]; or group B coxsackieviruses) (116), or other paralytic conditions (5, 74) (e.g., injury to the spinal column resulting from periostitis/osteomyelitis, snake or tick bites, schistosomiasis [blood fluke infection], chemical poison, or following administration of anesthesia and certain drugs). (116)

Risk Factors for Wild-type Paralytic Poliomyelitis

Children in developing countries get infected with the wild-type poliovirus because they have not been immunized. (88) Another factor to consider is a compromised environment (because of poor sanitation and high population density) that is a potential source of poliovirus activity. The poor immune status of the community due to inadequate nutrition (80, 81) has also been thought of as a contributing factor; however, this still remains controversial.

Immunity

Poliomyelitis confers type-specific lifelong immunity. Carrier states (asymptomatic persons excreting poliovirus for more than 6 months after infection) are rare and have been reported only in immunodeficient persons. (1)

Complications

Severe poliomyelitis can result in limb deformity such as flexion contracture of the knee or lateral rotation deformity of the tibial bone, leading to impaired mobility. (82, 83) Other complications of poliomyelitis may include impairment of respiration due to paralysis of the respiratory muscles, airway obstruction due to involvement of cranial nerve nuclei, or lesions of the respiratory center. Myocarditis, gastrointestinal problems (hemorrhage, paralytic ileus, gastric dilatation), and urinary tract infections also have been reported. (4)

Postpolio Syndrome

A late-onset syndrome (postpolio syndrome [PPS]) has been reported with increasing frequency occurring in patients 30 to 40 years after they contracted wild poliovirus infection in childhood. This condition does not involve poliovirus persistence. (106) The cause is unknown but probably is related to the aging or death of nerves and muscles that were compensating for the original damage. Another theory suggests an ongoing process of denervation (deprivation of nerve supply) and reinnervation (restoration of nerve supply) that occurs in postpolio patients. These patients experience muscle pain and exacerbation of existing muscle weakness. Risk factors for developing the post-polio syndrome include (a) increasing length of time since acute poliovirus infection, (b) presence of permanent residual impairment after recovery from the acute illness, and (c) female sex. (1, 2, 10, 74, 77, 92)

Management

Management of poliomyelitis is supportive and symptomatic, since antiviral agents specific for the treatment of this illness are not available. Patients with abortive or mild nonparalytic poliomyelitis may require only bed rest for several days. Analgesics, antipyretics, or hot, moist packs applied to muscles may be helpful in alleviating the symptoms. During active myelitis, rest on a firm bed is advisable. Physical therapy is very important in the management of paralytic poliomyelitis during the convalescent period. (4) Patients with permanent impairment require not only physical therapy, but also orthopedic management, psychological support, and education on self-care strategies. Chronic stress to the affected muscles should be minimized and other factors that may result in the development of postpolio syndrome, including disuse weakness, overuse weakness, and insidious weight gain, should be controlled. Patients with PPS may

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require individualized exercise and cardiorespiratory fitness programs that should stress joint protection, moderation in exercise, and the pacing of activity and rest. Exercises to strengthen underactive muscles should be balanced with rest for the overworked muscle groups. Other useful aids for these patients include assistive devices, surgery, and various tips for daily living. (91, 92, 93, 94, 95)

Disease Prevention

Poliovirus Vaccines

There are two types of poliovirus vaccines that are available and that have been used effectively for many years in controlling paralytic poliomyelitis:

- The injectable, inactivated poliovirus vaccine (IPV) developed by Salk and introduced in the 1950s; (11) the ability of IPV (or the enhanced IPV [eIPV]) to eradicate poliovirus in developing countries where fecal-oral transmission is prevalent is doubtful and, therefore, this vaccine is not considered an option for eradication of poliomyelitis. (12)
- The oral, live attenuated (less virulent) poliovirus vaccine (OPV) developed by Sabin and introduced in the 1960s; (11) OPV is the vaccine of choice for eradication of poliomyelitis, especially in areas where wild poliovirus has recently occurred or is currently circulating, and/or in areas where inadequate sanitation necessitates an optimal mucosal barrier to wild-type virus circulation. (90) It is the vaccine recommended by the World Health Organization (WHO) Expanded Programme on Immunization (EPI).

Polio Global Eradication Efforts

The incidence of poliomyelitis has declined rapidly in many industrialized countries because of the widespread use of poliovirus vaccines, especially OPV, (88) since the 1950s. In 1985, the member countries of the Pan American Health Organization adopted the goal of eliminating the disease from the Western Hemisphere by 1990, and, in 1994, an international commission certified the Western Hemisphere to be free of indigenous wild poliovirus. (11, 13, 14)

In 1988, the World Health Assembly, which is the governing body of WHO, adopted the goal of global eradication of poliomyelitis by the year 2000. (15) The WHO Polio Eradication Initiative (PEI) is a global partnership that includes ministries of health in the polio-endemic countries, the Rotary International, United Nations Children's Fund (UNICEF), the U.S. Centers for Disease Control and Prevention (CDC), nongovernmental organizations, bilateral agencies such as the U.S. Agency for International Development (USAID), UK Department for International Development (DFID), Australian Agency for International Development (AUSAID), Danish International Development Assistance (DANIDA), Japan International Cooperating Agency (JICA), and others. Remarkable progress toward meeting this goal has been achieved in many WHO regions. It is believed wild poliovirus transmission has ceased in the WHO Western Pacific region, which includes China, and the WHO European region. Polio is now concentrated only in parts of sub-Saharan Africa and the Indian subcontinent. Eleven years after WHO launched the global PEI, the number of polio cases has decreased by more than 90% from an estimated 350,000 cases; the number of polio-infected countries has dropped from 125 to 30. (1, 16, 17, 105, 106, 107)

WHO Strategies for Global Polio Eradication

Global polio eradication is based on the following WHO strategies: (1, 16, 17, 107)

- A high level of routine immunization coverage of infants with at least three doses of oral poliovirus vaccine.
- Annual National Immunization Days (NIDs), during which two supplemental OPV doses are given to all children younger than 5 years of age regardless of prior immunization status; two rounds of NIDs per year for at least three consecutive years usually are required in polio-endemic countries.
- Laboratory-based surveillance for all cases of acute flaccid paralysis (AFP) (defined as an acute onset of paralysis of one or more limbs with decreased or absent tendon reflexes in the affected limbs without other apparent cause and without sensory or cognitive loss) in children younger than 15 years of age, with the collection and virological examination of two stool specimens from every case.
- "Mopping up" immunization campaigns to administer supplemental OPV doses through house-to-house campaigns in areas with persisting transmission of wild poliovirus.

Routine immunization coverage remains the basis on which PEI is built. High levels of seroconversion and interruption of poliovirus transmission have been achieved with three

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doses of OPV in the routine immunization programs in temperate, industrialized countries. (17, 18, 19) Wild poliovirus transmission still persists in some tropical developing countries because of failure to immunize children. (88) Other factors include poor sanitation, high population density, high maternal antibody levels, competing enterovirus infections, and diarrhea, all of which can affect transmission and seroconversion rates. In these circumstances, high routine immunization coverage seems only to reduce transmission to low levels; supplemental OPV doses (through NIDs and "mopping up" campaigns) are therefore necessary to interrupt transmission by rapidly increasing gastrointestinal immunity in the population, thereby limiting the spread of the virus. (17, 18, 19) Surveillance for AFP is done to monitor progress of polio eradication, identify remaining areas where wild virus transmission still exists for the "mopping up" immunization campaigns, and provide the basis for certification of eradication.

Pediatric routine immunization with the use of poliovirus vaccine varies among and within countries. Immunization usually is assessed on an individual basis for each country, considering factors such as cost, health care structure, and level of transmission of the wild poliovirus. (11) For the immunization schedule recommended by WHO using OPV, see the section on *Oral Poliovirus Vaccine* below.

Oral Poliovirus Vaccine (OPV)

OPV is used for routine immunization and for global eradication of polio. (20) WHO recommends that infants receive four doses of trivalent live OPV, at birth and at 6, 10, and 14 weeks of age, respectively. If a dose of OPV is not given at birth, then the fourth dose should be given at the time of the measles immunization contact, or at any other contact with the health care system during the first year of life. There should be an interval of at least 4 weeks between any two doses. (12) These OPV doses are part of the basic routine immunization coverage recommended by the EPI to protect children against major causes of morbidity and mortality in childhood, especially in endemic countries. (21, 105)

Advantages of OPV

OPV offers the following advantages: (12, 88)

1. It rapidly induces a long-lasting immunity.
2. It is easy to administer, requiring no needle or syringe.
3. It induces a high degree of gastrointestinal immunity, suppressing excretion of wild poliovirus.
4. It induces a high level of population immunity (herd immunity), thereby reducing transmission of wild poliovirus.
5. It is less expensive.

OPV has the ability to induce secretory immunity in the intestinal mucosa, which is the primary site of viral replication. (20) Person-to-person spread of the vaccine virus may help protect unimmunized persons or boost the immunity of those already vaccinated. (22, 23) OPV induces herd immunity in two ways: (a) OPV recipients may shed the live attenuated vaccine virus that can infect (and protect) their contacts, and (b) when OPV recipients are exposed to the wild poliovirus, shedding of the virus through feces and pharynx is reduced. (24) The ease of administration (oral), which results in simplified logistics (operations) and improved safety of mass immunization campaigns, low cost, and availability make the OPV ideal for use in both developing and industrialized countries. (21)

Disadvantages of OPV

OPV has certain limitations:

1. Suboptimal seroconversion rates after three doses reported in tropical developing countries.
2 Poor thermostability of the vaccine.
3. Extremely rare occurrence of vaccine-associated paralytic poliomyelitis (VAPP) in vaccine recipients (7, 8, 9, 12, 21, 26, 33) and their contacts. (106)

High degrees of seroconversion have been attained with the use of two or three doses of OPV in temperate, industrialized countries; the seroconversion rate after three doses of OPV is reported to be greater than 90% in response to all three types of poliovirus. (12, 25) In tropical countries, however, seroconversion after three doses averages only 73%, 90%, and 70% for types 1, 2, and 3, respectively. (26) Suboptimal seroconversion may be due to the following factors: interference among the three strains of vaccine virus, high levels of maternal antibodies, a seasonal effect which is probably related to interference from other enteroviruses, and diarrhea. To enhance seroconversion in developing countries, a variety of approaches have been considered, including

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increasing vaccine potency, revaccinating infants who had diarrhea at the time of the previous dose, providing supplemental doses of OPV in routine programs or NIDs, which are usually held at the time of the year when seasonal effects are favorable (dry cooler months and usually low incidence of diarrhea), and administering the vaccine to children at older ages to reduce the effect of passively acquired antibodies from the mother. (26, 27, 28, 29, 30)

IPV has been proposed to resolve the issue of suboptimal seroconversion with the use of OPV. (26) IPV, however, produces inadequate secretory intestinal immunity and will not eradicate polio in developing countries when used alone. (20) Maternal antibodies reduce the seroconversion response to IPV and thus may not immunize infants in countries where polio is endemic. Mixed OPV/IPV schedules (which are used in some developed countries) provide improved systemic immunity, but intestinal secretory immunity does not differ from that provided by OPV alone in developing countries. (31) Because of the cost and the complexity of administration, mixed OPV/IPV schedules are not considered suitable for routine immunization in developing countries. (21)

In general, live attenuated vaccines such as OPV are more heat-sensitive than inactivated vaccines. (85) OPV must be stored and transported under refrigeration to avoid heat exposure that can render it useless (84) (recommended storage temperatures: -15 degrees Celsius in central or provincial cold stores and 0 to +8 degrees Celsius in health facilities). (109) This storage requirement must be adhered to from the time of manufacture to the administration of the vaccine to the patient, a process referred to as maintenance of the "cold chain." (84) Excessive heat exposure may result from transportation problems, equipment and power failure, and hot and humid climates. In the past, such exposure to heat generally was not detectable and many vials of vaccines were discarded when heat exposure was suspected, even though this may not have been necessary.

Thermosensitive vaccine vial monitors (VVMs) containing a heat-sensitive chemical that changes color irreversibly as heat exposure occurs have now been attached to vials of OPV, thereby reducing the chance of thermally inactivated vaccine being given to children. (21, 33, 34) When the cold chain is above +8 degrees Celsius, VVMs should be used as monitoring tools to ensure viability of the vaccine. (109) VVMs enable these vaccines to be used to the limits of their stability. These markers help health workers to identify and discard vaccines that have been exposed to excessive heat or to save and use vials that have not had too much heat exposure. As long as the VVM indicates no thermal inactivation of the vaccine and visual inspection shows no contamination, a vial of OPV can be used until it is empty. Proper use of VVMs can result in significant reduction of wastage of OPV. (34) To further decrease the likelihood of problems from excessive heat exposure, NIDs are conducted during the cool season. (21)

In rare instances, administration of OPV has been associated with subsequent paralysis in healthy recipients and their contacts. This may be caused by the attenuated poliovirus in the vaccine reverting to virulence by mutation. The risk of vaccine-associated paralytic poliomyelitis (VAPP) is extremely small, occurring at a rate of 1 case for every 2.5 million OPV doses administered or 1 case in 700,000 first doses administered, (6, 8, 32, 88) compared with an incidence of 2 to 5 cases of paralytic poliomyelitis due to the wild poliovirus for every 1000 nonimmunized children in highly endemic countries. (21) The risk of VAPP is greater after administration of the first dose or when OPV is given to adults or immunocompromised persons. (2, 9, 24)

Use of IPV has been proposed to resolve the problem of VAPP. However, the high cost of IPV, the inadequate secretory immunity it provides, and the requirement for sterile injections given by medical personnel make it unsuitable as a means for polio eradication in developing countries. (21) Use of IPV alone also may provide a lower level of overall population immunity because the vaccine virus is not spread from person-to-person, especially in areas where wild virus is still circulating. (21, 88) Polio eradication will provide a complete and permanent solution to VAPP. (21)

Contraindications

As with any vaccine, misunderstandings about contraindications to the use of OPV exist. Breast-feeding and malnutrition are not contraindications to the use of OPV. In general, OPV can be given to a child who has mild diarrhea. The decision about whether or not to vaccinate a child with a concurrent illness depends on the severity of the illness. (1) Mild to moderate febrile illness not requiring hospitalization is not a contraindication to the use of

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OPV. Children who are hospitalized should receive OPV before being discharged from the hospital. (88)

Generally, live vaccines should not be given to individuals with immunodeficiency diseases, or to individuals who are immunosuppressed due to malignant diseases, or to those undergoing therapy with immunosuppressive agents or irradiation. OPV, however, should be given to persons with human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS) infection. (12)

Most vaccines can be safely and effectively administered simultaneously, thereby raising immunization rates significantly. There are no known contraindications to the simultaneous administration of the multiple vaccines routinely recommended for infants and children. Immune responses to one vaccine generally do not interfere with responses to other vaccines. OPV may be administered concurrently with other vaccines, such as measles vaccine. (89, 90)

The conditions most often wrongly considered to be contraindications to immunization in Europe, (39, 105) in the U.S., (40) and in developing countries (39) are listed in *Table 1*.

Table 1. The following conditions ARE NOT contraindications to immunization (12)

1. Minor illnesses such as upper respiratory infections or diarrhea, with fever < 38.5 °C (41)
2. Allergy (except anaphylactic reactions to neomycin or streptomycin), (58) asthma, or atopic manifestations, hay fever, or "snuffles"
3. Prematurity, small-for-date infants
4. Malnutrition
5. Breast-fed infants
6. Family history of convulsions
7. Treatment with antibiotics, low-dose corticosteroids, or locally acting (e.g., topical or inhaled) corticosteroids
8. Dermatoses, eczema, or localized skin infection
9. Chronic diseases of the heart, lung, kidney, or liver
10. Stable neurological conditions, such as cerebral palsy and Down syndrome
11. History of jaundice after birth

Beliefs and Knowledge About Vaccinations

General

The United States Pharmacopeia (USP) has joined USAID and other cooperating agencies to address the issue of misconceptions that are known to exist about vaccinations, particularly in developing countries, and to raise awareness about the value and safety of vaccines such as OPV.

Modern vaccines are extremely safe. However, all vaccines may produce some degree of unwanted reaction. Most adverse events are trivial and harmless while a very small number are serious and potentially life-threatening. It should be noted that the benefits of protection provided by vaccines against the diseases these vaccines prevent always far exceed the slight risk of an adverse reaction. (64, 66, 113, 114)

Examination of popular perceptions about vaccinations, local interpretations of diseases prevented by vaccines, associated local illness categories, as well as perceptions of utility of and need for vaccinations, is important in the assessment of community demand for vaccinations in developing countries (42) and the design of communications strategies to overcome community barriers/constraints. (81)

Socio-political

Vaccination programs usually are introduced within the socio-political context. Positive news reported by the press praising the government and international agencies in their effort to improve children's health may give the impression that these programs are popular and appreciated by all the people of developing countries. However, such an impression is not always true, as a small, but vocal, group of people (in the general populace or scientific community) may have a sense of ambivalence and mistrust toward these programs. In one Asian country, a conspiracy theory appeared associating vaccinations with foreign Christian countries with intent of converting the local population to Christianity. Medicine was viewed as a vehicle of ideology. (42) Certain segments of the population have linked vaccination initiatives to coexisting national directives such as family planning. Another conspiracy theory emerged regarding this issue and was widespread in the 1970s during the country's "emergency" exercise of state power in the name of population control. Mistrust reappeared in the 1990s, a time of increased ethnic and religious tensions and while clinical trials were being conducted on a new

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anti-fertility vaccine (43) in the country. As a result, one community expressed its desire to receive vaccinations from private practitioners rather than from the staff in government primary health care centers. (42)

Vaccinations also have been associated with negative beliefs about family planning in some countries in South America. Vaccinations will not cause sterility, as some people of one South American country, who have little idea what diseases vaccinations protect against, are reported to believe. (44)

Discussion of vaccination programs has also served as a platform to address issues related to foreign policy and national identity. In some countries, introductions of foreign vaccines have raised concern about national boundaries and a sense of moral geography. Fears have been expressed about violation of national security through collection of computerized data on the genetic makeup of the population. Some people questioned the wisdom and motivation of intensive vaccination campaigns and herd immunity. They criticized these campaigns as exploiting the plight of helpless young children and resulting in the diversion of resources (allocated to vaccination programs) from other national health programs (e.g., tuberculosis). (42, 75) These critics are not against vaccination per se but are questioning the imposition of a vaccination campaign complete with targets, plans for community surveillance, and the possibility of coercion. They believe that it is only when vaccinations are recognized as a perceived need and demanded by the "community" that they become community development resources in a "comprehensive primary health care" sense.

To allay the concerns of these critics, it should be explained that vaccination programs are not meant as campaigns to make the community dependent and powerless to decide upon its own health care priorities. (42) Rather, it should be emphasized that children have the right to good health. Prevention of disease and disability through safe and effective vaccines will improve their quality of life as well as that of their families. (81)

Cultural

Cultural factors influence acceptance of and demand for vaccinations. These include perceptions of vaccinations and vaccine-preventable diseases, perceptions of vulnerability and protection, as well as the role of medicines in promoting and maintaining health. The setting in which vaccination programs are introduced to the community also may determine how vaccinations are received by the people, as discussed above. A study conducted in two countries in South Asia in the early 1980s reported that local populations had a poor understanding of the purpose of vaccinations and what kinds of diseases they prevent, resulting in misconceived notions and unrealistic expectations. Mothers often have little knowledge or an exaggerated idea about the diseases prevented by vaccinations; those who have knowledge about such diseases are more willing to accept vaccinations than those who do not know which diseases the vaccines prevent. (42)

Local beliefs about the purpose of vaccinations can be problematic. In developing countries, beliefs such as "vaccinations are good for the health of the child" and that "vaccinations protect against serious illness" are fostered by vague health education messages. (42, 111) These vague messages are offered to mothers as quick explanations for why they should comply with health worker directives or as "the only messages illiterate mothers can understand." As a result, some people think that all vaccines are alike and that they improve a child's health in an incremental manner; therefore, the number of vaccinations rather than the types of vaccinations may be one of the demand criteria. Results of a survey conducted in two countries in South and Southeast Asia indicated that only 40 to 50% of mothers surveyed thought that vaccinations protect against specific illnesses. Two studies on vaccination conducted in another country in Southeast Asia found that mothers who do not fully vaccinate their children believe their partially vaccinated children to be healthy and, therefore, not in need of further immunizations. (42) Such misconceptions exist in developed countries as well, as observed in a community survey conducted in one state in the U.S. in 1991 assessing the immunization status of children 2 years of age. (45)

General messages may lead some people to believe that vaccines protect against diseases they are not designed to prevent. Such expectations may result in perceptions that vaccinations are not very effective, especially when vaccinations are temporarily associated with diarrhea, acute respiratory infection, malaria, dracunculiasis, goiter, dengue, and other diseases. Other people believe vaccinations are similar and that they protect against all sudden and serious illnesses, promote growth and increased weight of infants, cleanse children's blood and intestines so that no disease will afflict their bodies, and prevent illness from becoming serious (e.g., simple diarrhea to gastroenteritis). (42)

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Researchers who conducted a community study in one African country observed that mothers accept vaccinations because they believe vaccines can reduce the severity of illness such as measles. (46)

Another perception resulting from general messages involves vaccination compatibility. Because of the belief that vaccinations are "good for health" and "similar," mothers have the tendency to assess "them all" as incompatible if the child experiences a marked side effect (e.g., high fever) to any one vaccine or suffers an illness not related to vaccinations. Some mothers then weigh the ascribed benefits of future vaccinations against the state of ill health suffered by the child. Further, general messages may result in the perception that vaccinations are only for selected segments of the population–infants and women. (42)

In some countries, communication problems may arise in cases where there are no local illness terms that correspond to the diseases prevented by vaccination, or, if there are, such terms may include diseases not prevented by the vaccines. This issue may have an impact on people's expectation about the efficacy of vaccinations. (42)

Vaccinations may be perceived as magic similar to talismans, providing protection against evil forces, especially for children and pregnant women. In one West African country, vaccinations are likened to amulets, which needed to be renewed periodically. (47) To some people who are opposed to vaccinations, it should be made clear that vaccinations are not "the modern equivalent of witches' brews, brutally injected into babies' pristine bodies," as some have claimed. (62)

Lack of Adequate Knowledge/Information

Others refuse immunization because they do not believe in the use of western medicine or because they simply find immunization unacceptable or do not perceive the diseases to be a risk to their family or in their community. (104, 109) Some parents refuse immunizations for their children because of their misconception that immunizations weaken the immune system and cause illnesses such as persistent colds, runny noses, "glue ear," hyperactivity, and asthma. (48) It should be explained to these parents that immunizations enhance rather than weaken the immune system and that they do not cause the minor illnesses mentioned.

Religious

In some cases, parents refuse immunizations because of religious reasons, such as belief in divine healing. One religious group, for example, thinks that healing is the natural result of drawing closer to God and therefore immunizations are not necessary. (45, 48, 103) An outbreak of 80 cases of paralytic poliomyelitis that occurred in The Netherlands in 1978 affected persons who were not immunized because of religious objections to immunizations. (49) From September 1992 through February 1993, a large outbreak due to poliovirus type 3 occurred again in the same country among persons belonging to a religious group. (50) In 1979, an outbreak of polio occurred in four states in the U.S.; this was traced back via Canada to the outbreak in The Netherlands in 1978. (51, 71) In this 1979 U.S. outbreak, ten paralytic poliomyelitis cases were reported affecting persons belonging to religious groups with objections to immunizations. (51)

Misconceptions on OPV

Oral poliovirus vaccine has been falsely associated with family planning in several African countries. (108, 109, 110) In one country, it was believed that OPV causes impotence in children. In another, the community and some health care workers have repeatedly questioned the rationale of NIDs since their inception in 1996. One church group had been very vocal about the NIDs and considered this polio eradication campaign as a strategy to control population or as a means of introducing a mutation that could result in HIV/AIDS infection. They accused the government of concentrating its efforts on polio control at the expense of malaria, typhoid and other water-borne diseases, and cholera. They argued that the funds used for this campaign be used for relevant health programs such as improving sanitation and controlling environmental pollution. Group members viewed these immunization campaigns as prelude to something more sinister, a serious concern that may affect future campaigns, especially if injectable vaccines are to be added. Political and religious advocacy and health education efforts have been made to dispel the rumors. Talks were held to convince this group that their expressed apprehension was unfounded and they were asked to support the mass campaign. The group finally acknowledged that OPV was harmless and cited their lack of information about the PEI as the reason for their negative attitude toward the NIDs. (97, 98, 99, 100, 101, 102, 104)

A study conducted in a South Asian country identified

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some of the reasons for nonimmunization or postponement of immunization with OPV among children younger than 5 years of age. The most common reason for nonimmunization was that the parents (especially from rural areas) were not aware of the need for immunization. Incomplete immunization was attributed to unawareness of the need to return for the second or third dose. Having a minor ailment (e.g., mild upper respiratory tract infection or diarrhea) was another common reason for nonimmunization or incomplete immunization. Fear of adverse reactions, misconceptions about contraindications (see *Table 1* above), and lack of interest also have been reported. (52, 75)

In one of the NIDs conducted in South Asia in 1995, many caretakers considered their children to be fully immunized and felt they did not need the OPV. They were afraid that "too many doses" given can produce harmful side effects, especially if the child had already received the routine polio vaccine. (53) This same fear was expressed by some parents during an outbreak of polio in one South West African country; they refused to have their children immunized because of anxiety over the safety of sequential rounds of OPV. (54) Such fear is not warranted, as several doses of OPV are necessary to ensure that initial seroconversion against all types of poliovirus has been attained for protection against poliomyelitis. (12)

Recently, concerns have emerged following reports of the association of certain vaccines with the development of disorders such as autism, inflammatory bowel diseases, and type 1 diabetes. However, there are no reliable scientific data to support these alleged connections. (59, 60, 61, 72, 73) Some reports have suggested that OPV can cause Guillain-Barré syndrome, (35) and acquired immunodeficiency syndrome (AIDS). (55, 56) The existence of such allegations may deter people from receiving the needed polio vaccinations. Upon examination of two studies in Finland that reported an association of the use of OPV with a rise in cases of Guillain-Barré syndrome, (35, 65) a U.S. Institute of Medicine committee concluded that there was a causal relation between use of OPV and the occurrence of Guillain-Barré syndrome. (36) However, reanalysis of these data (1) and a retrospective epidemiologic survey carried out in southern California failed to find a correlation between the two. (37, 38)

OPV does not pose and has never posed a risk of transmitting the AIDS virus or any related virus to humans. This was the conclusion reached by the U.S. Public Health Service, WHO, and other leading medical authorities after evaluating two separate theories that appeared in the media in March 1992, suggesting that AIDS might have been accidentally introduced into humans by live poliovirus vaccines that might have been contaminated with unknown monkey viruses. (55, 56) To refute the credibility of these theories, an analysis was conducted by researchers affiliated with the U.S. Food and Drug Administration (FDA) on 12 lots of monovalent live attenuated oral poliovirus vaccine types 1, 2, and 3 (which were released for use by a North American manufacturer between 1976 and 1989) for the presence of HIV-1 and simian immunodeficiency virus (SIV). Results of the various assays failed to detect the presence of HIV/SIV in these monovalent vaccine lots. (57) Recently, a theory appeared in a U.S. newspaper article that was written in relation to the publication of a new book that presented the hypothesis that HIV was first transmitted to humans during initial large-scale tests of OPV that used chimpanzee cells. Two researchers who were involved in the African trials disputed the theory, stating that no chimpanzee tissues were used in the production of OPV. (96)

Addressing Misinformation

Raising General Awareness

It is important to note that as vaccine-preventable diseases decline due to effective immunization programs, memories about the diseases and their associated risks fade away. Because of the lack of disease awareness, people often tend to see only the adverse effects of vaccines, prompting reluctance to accept vaccinations. (62, 64)

Promoting public awareness through education, addressing misconceptions, and stressing the importance of vaccinations is necessary. People should be informed of the relative risks and benefits of vaccinations and the ill effects of the diseases that can be prevented by the vaccines. Public information on vaccinations should be balanced, presenting details about the benefits as well as relative risks. (62, 63, 64, 78, 109) Messages and information need to be concise and simple, yet technically correct and not misleading. Caregivers need to be aware of and accept the need for vaccination. They should have a basic understanding that

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a series of vaccinations and sometimes supplemental doses of specific vaccines are needed for their children to be fully protected. (109)

Investigations concerning adverse reactions to the vaccines should be released to the public but accompanied by information on how these adverse reactions could have been prevented or under what special circumstances they occurred. Direct reactions to statements against vaccinations should be issued. (62, 63, 64, 78, 109)

Improving communication between health care providers (and their health staff at clinics) and the patients and their parents/caretakers is important. (48) Promotional strategies will depend on the nature and readiness level of the targeted population. (104, 111) Initiatives can be set up wherein questions regarding immunizations can be answered promptly by the health department staff. The families should have the opportunity to discuss concerns about immunizations with the local Expanded Programme on Immunization (EPI) staff. (48) Sensitization meetings also can be set up at the community levels and door-to-door promotions can be carried out by the outreach workers to combat misunderstanding/misconceptions by people belonging to religious and other groups that are against immunization. In some developing countries, getting the religious leaders, chiefs, "influence brokers" or other credible persons, and the media involved in the immunization campaign has been very effective in educating the population about the importance of immunization. Interpersonal communication or word-of-mouth still remains as one of the major channels of communication, especially for people living in the rural areas. (104, 108, 112)

The popular media provide an effective tool for advancing public health. They can raise awareness of the need for immunizations as a form of prevention. Pamphlets, posters, television, and radio, which can reach a large number of people are being used to improve public awareness on this issue. Use of pictures and photographs may help people understand the diseases that can be prevented by the vaccines, and their sequelae. A prospective randomized trial in the U.S. recently demonstrated the effectiveness of videotaped information in increasing the knowledge about poliomyelitis and the poliovirus vaccines/schedules in parents/guardians of 2- to 3-month-old infants. (52, 67, 68, 69, 70, 76, 108)

In developing countries, cultural perceptions that run in opposition to vaccination should be refuted through clear, culturally-sensitive explanations of the preventive and protective qualities and benefits of vaccination by well informed individuals who are trusted by the community. (109) Health education programs should introduce new information in culturally sensitive ways that complement, rather than contradict, the existing views of the population. These program should include immunization in a way that will help communities see its value and claim it as an essential program. (117) It may be necessary to reinforce demand for preventive health care through strategies, such as making a completed course of immunization a prerequisite for school enrollment. (52, 67, 68, 69, 70, 76) This can help identify children who missed vaccination. Some polio eradication experts argue, however, that such a strategy may not be an effective approach in less developed countries, where cases occur at a younger age. Children need protection from diseases as early in life as possible. In developing countries where 90% of poliomyelitis cases occur before the age of 36 months, it may not be advisable to encourage parents to wait until their children are of school age to have them immunized. (81, 89, 109)

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Developed: 10/30/1998

Revised: 01/13/1999; 05/9/2000

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